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Professional Services

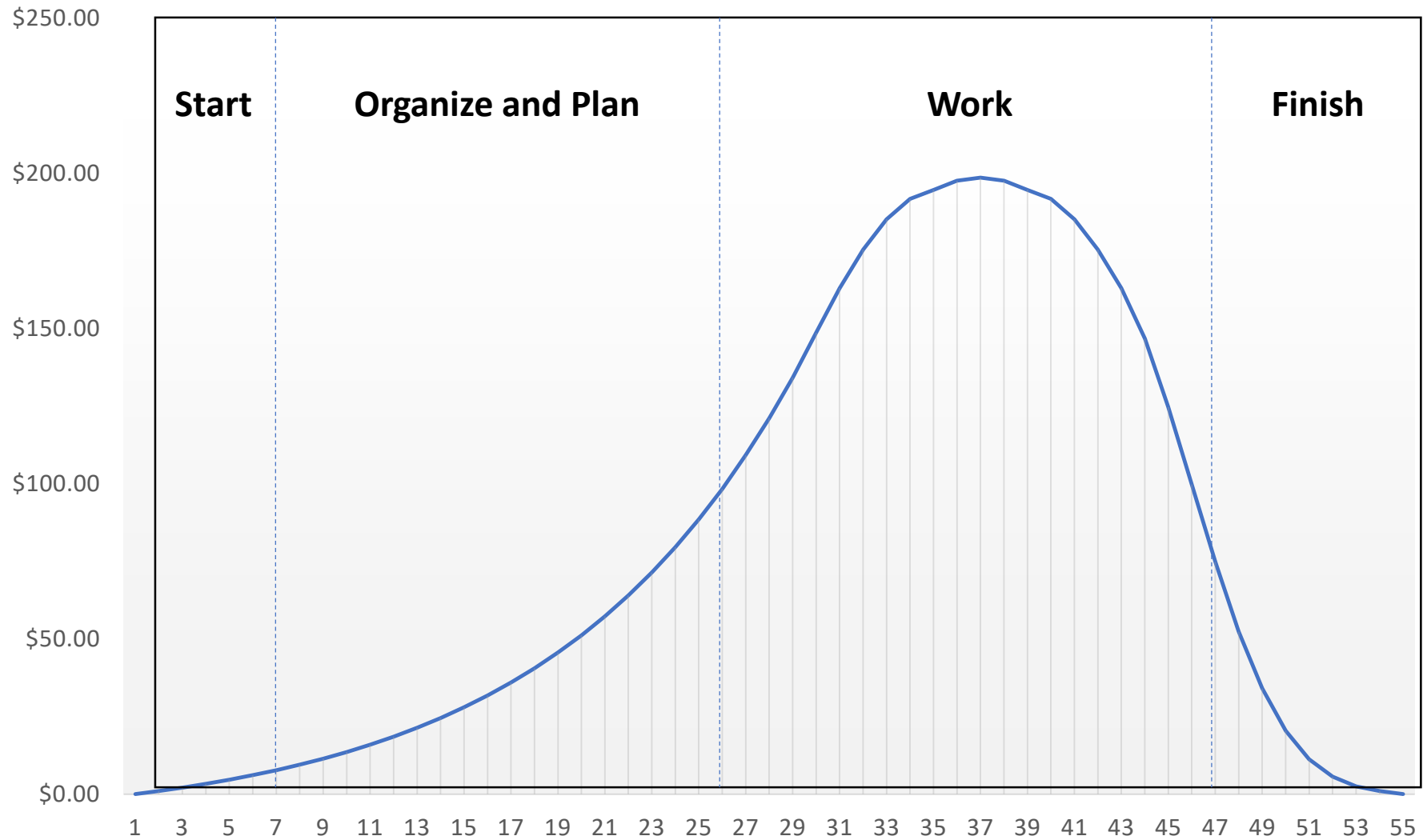
# Cost Management

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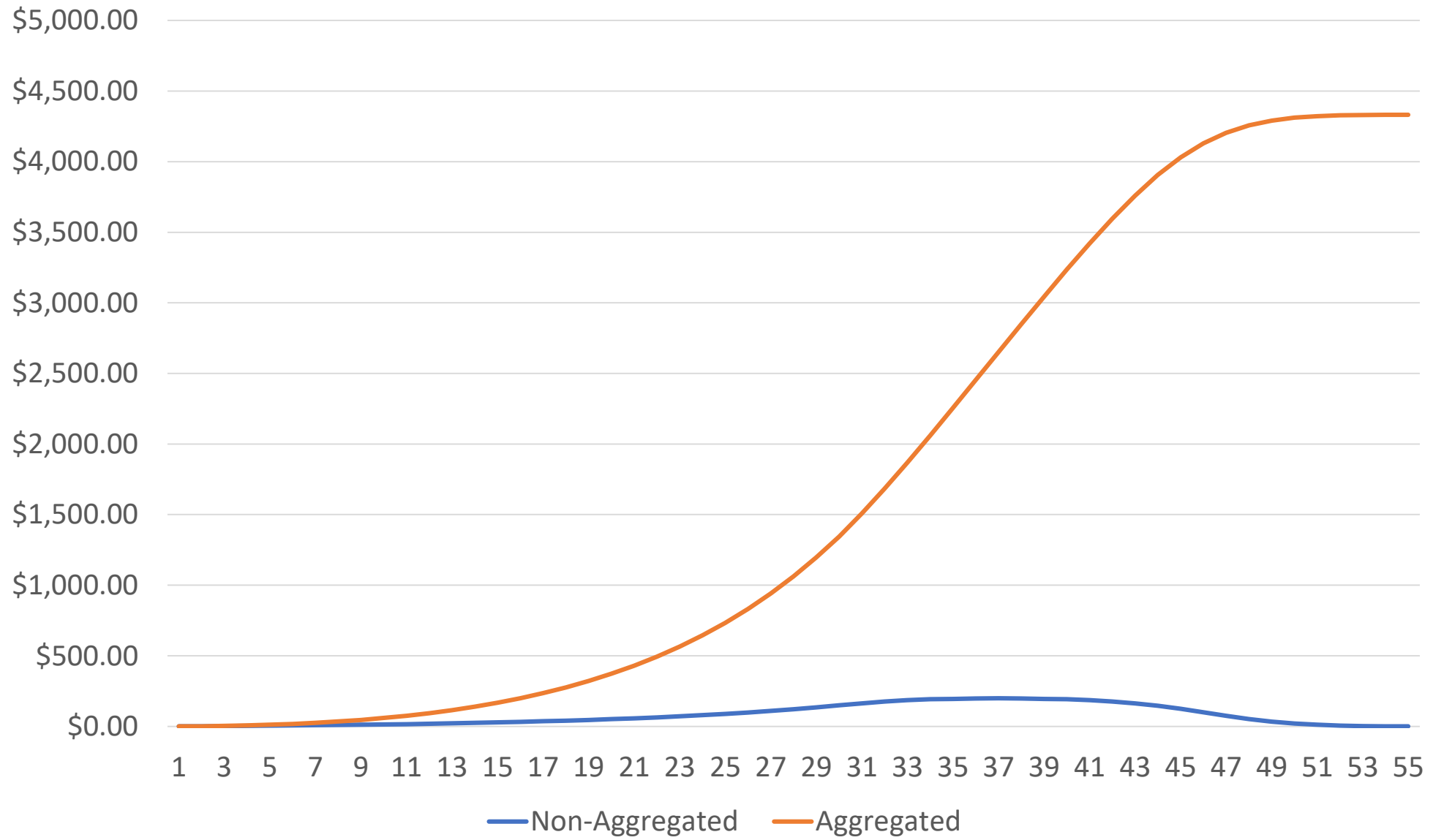
# Introduction

- Cost is a knowledge area primarily concerned with the cost of resources needed to achieve project goals.
- These processes are designed to estimate and control costs associated with a project

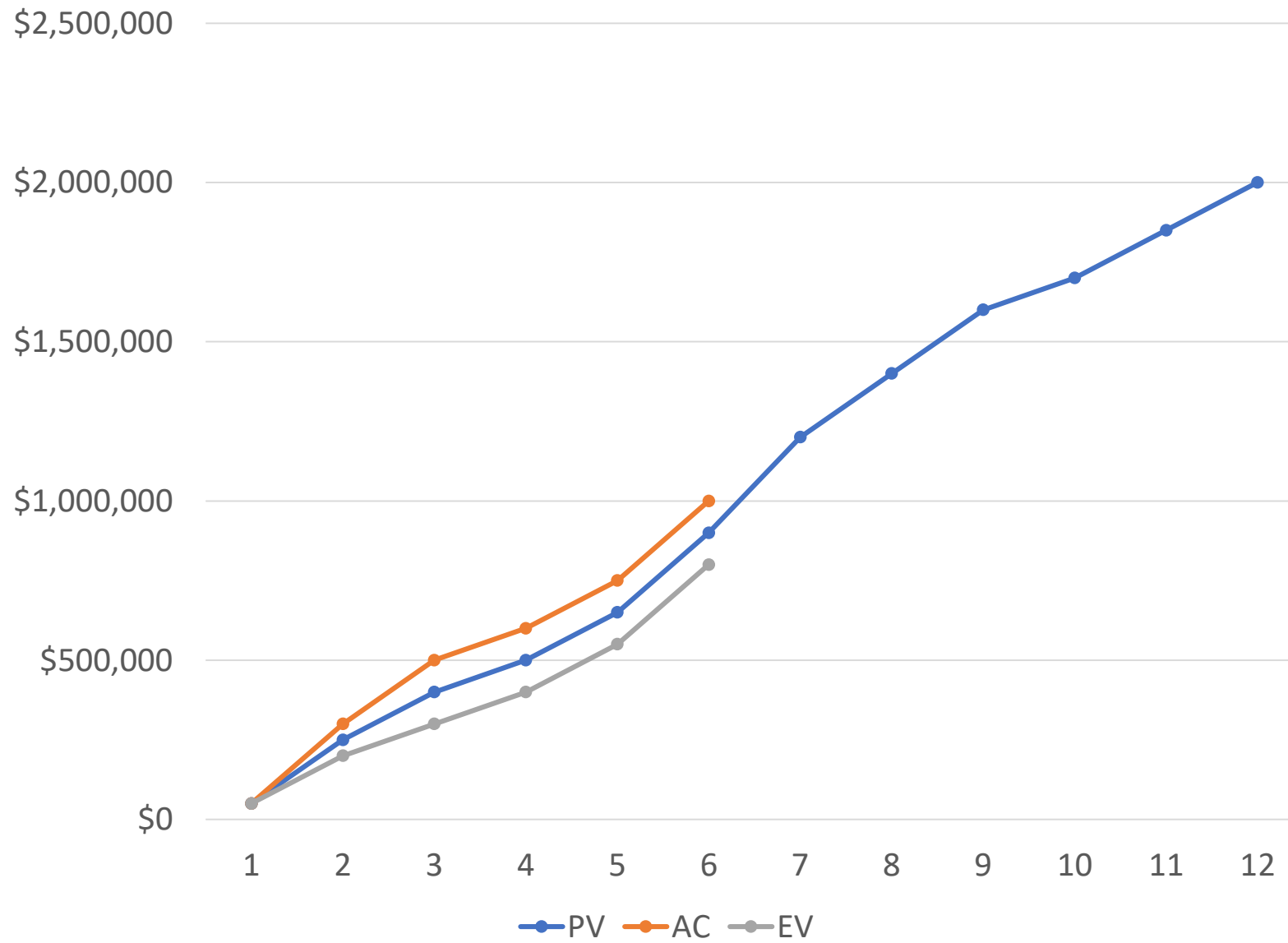
# S Curves



**Figure 7-1. Example Non-Aggregated Expenditure of Resources Over the Life of the Project**



**Figure 7-2. Example Aggregated (S-Curve) and Non-Aggregated Expenditure of Resources Over the Life of the Project**



**Figure 7-3. Sample S-Curves**

# Earned Value Management



# Cost Trends and Emerging Practices: Earned Schedule (ES)

- ES is an extension of earned value management
- Earned Schedule (ES):
  - Behind Schedule: When was the current value of the project supposed to have been achieved (on what date in the past)?
  - Ahead of Schedule: When is the current value of the project supposed to be achieved (on what date in the future)?
- Put more simply, ES = projected date of current earned value.
- If the project is on schedule, the earned schedule date and today's date are the same.

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# Cost Trends and Emerging Practices: Earned Schedule (ES)

- $SV = ES - AT$  (see figure next slide)
- $SPI = ES/AT$
- Corollaries:  $AT = ES - SV$  and  $ES = SV + AT$
- Note: You must know PV to calculate SV using this approach
- Where: EVM = Earned Value Management, SV = Schedule Variance, AT = Actual Time, SPI = Schedule Performance Index, PV = Planned Value

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$$SV = ES - AT$$
$$SPI = ES / AT$$

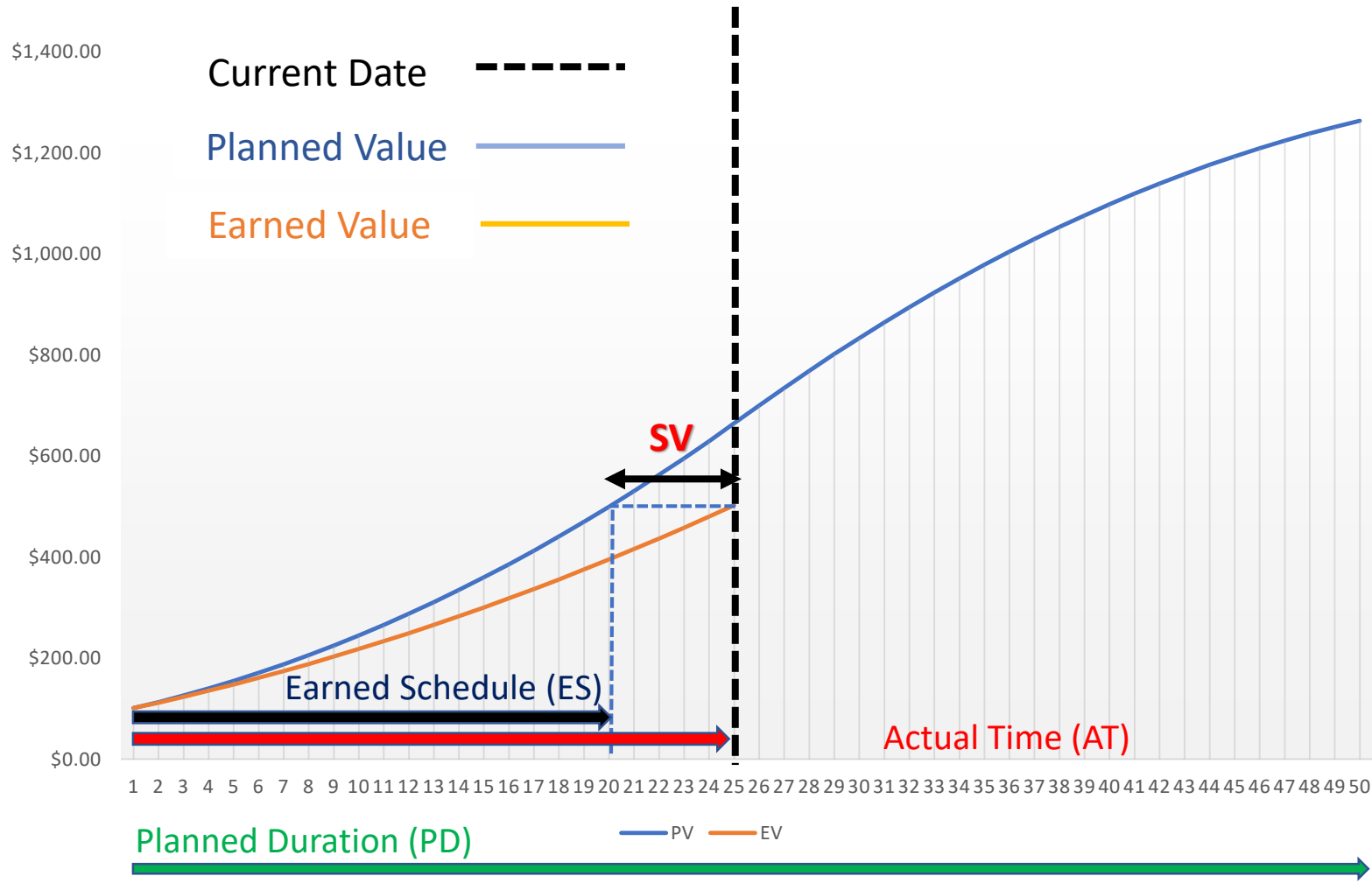
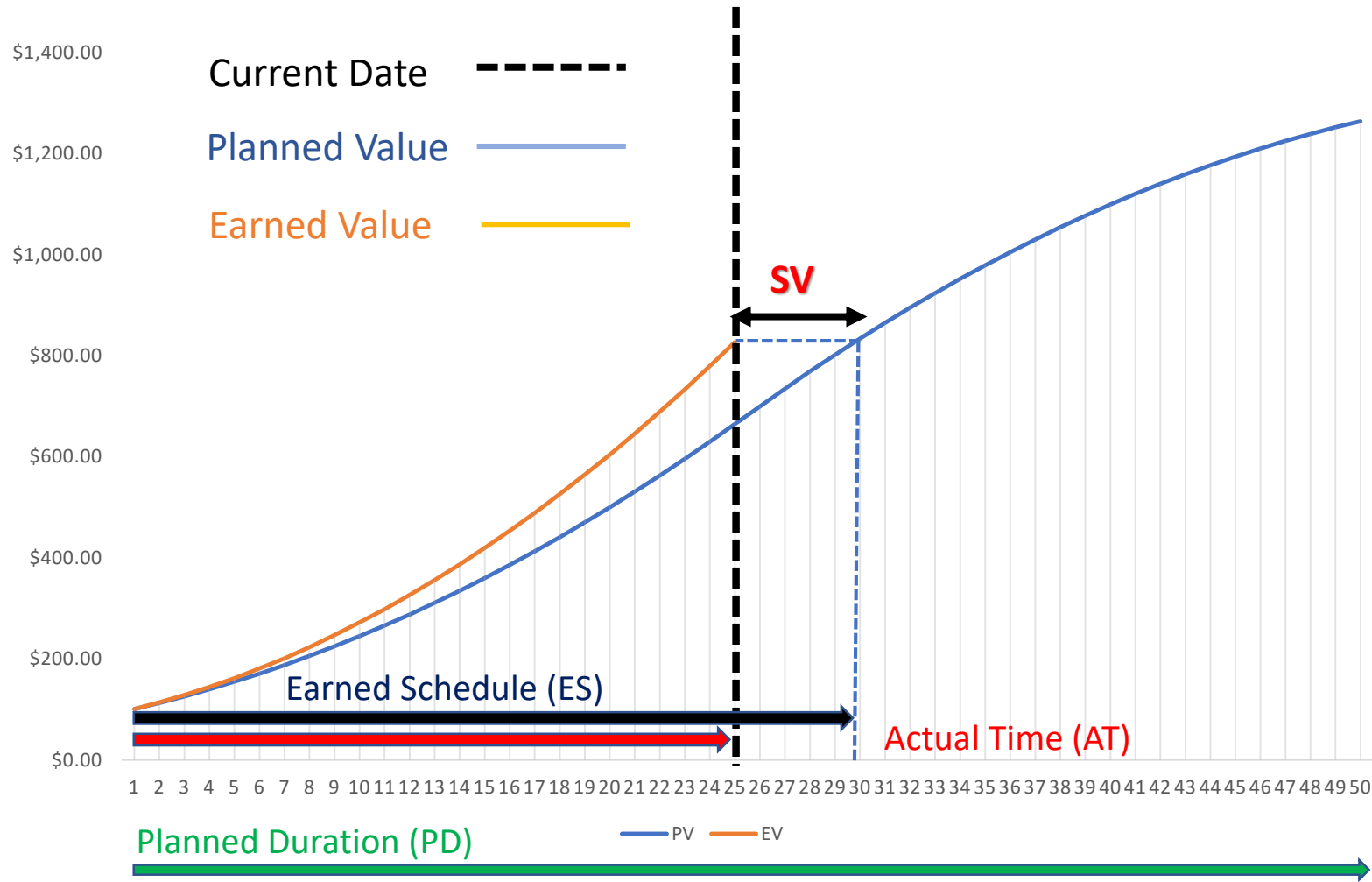


Figure 7-4. S-Curve Chart (Behind Schedule)

$$SV = ES - AT$$

$$SPI = ES / AT$$



**Figure 7-5. S-Curve Chart (Ahead of Schedule)**

# Cost Considerations for Agile/Adaptive

- In projects with high degree of uncertainty (especially scope), detailed cost analysis may not be beneficial
- High-level (“light-weight”) estimation methods may have more utility
- Detailed cost estimates can be used for short-term planning horizons
- In situations where there are strict budgetary restrictions, schedule and scope will have to be adjusted to meet the cost constraint as the project moves forward

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# Rules of Performance Measurement (Cost Management Plan): Credit Criteria

- Earned value (EV) rules/formulas (fixed formula progress reporting):
- Credit criteria (e.g., a work breakdown structure work package example might look like this: a 40%/60% rule, in which 40% credit is given upon initiation and the remaining credit (60%) is given upon completion.

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# Rules of Performance Measurement (Cost Management Plan): Work Breakdown Structure

- Work Breakdown Structure (WBS) level determination (at what WBS level will earned value be performed)
- Earned value rules are normally used for tasks or activities that are two reporting periods or less in length.

# Rules of Performance Measurement (Cost Management Plan): Weighted Milestone

- For tasks or activities more than two reporting periods, a weighted milestone method is used in which two or more milestones are established for measuring work completion.



# Three-Point Estimating

- Recall Program Evaluation and Review Technique (PERT) from Presentation 6. Be able to calculate a three-point estimate or expected value given the most likely estimate ( $C_M$ ), optimistic estimate ( $C_O$ ), and pessimistic estimate ( $C_P$ ) (triangular and beta distribution formulas respectively):

$$C_E = \frac{C_O + C_M + C_P}{3}$$

$$C_E = \frac{C_O + 4C_M + C_P}{6}$$

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# Cost Range

- A cost range is a cost estimate that is usually based on the level of ambiguity associated with a project at any given level of development.
- Later estimates have smaller ranges (more precise) than earlier estimates.

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<b>Estimate</b>	<b>Process Area</b>	<b>Tolerance Range</b>
Rough Order of Magnitude	Initiating	-25% to +75%
Budget	Planning	-10% to +25%
Definitive	Planning	-5% to +10%

**Table 7-1. Cost Range Table**

# Cost Aggregation

- Calculated by summing all resource calculations in Work Breakdown Structure (WBS) work packages
- Estimates are then aggregated at WBS component level, which eventually provides an overall estimate for project
- Type of *bottom-up estimating*

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# Cost Baseline

- Shows how much work should be accomplished by a certain date.
- Graphically represented as an S-curve in which cost estimates are aggregated for each time interval

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# Planned Value (PV) (1)

- Amount of resources officially budgeted for a Work Breakdown Structure (WBS) component or scheduled activity.
- PV is sometimes referred to as the budgeted cost of work scheduled (BCWS).

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# Planned Value (PV) (2)

- The total of the PV for a Work Breakdown Structure or scheduled activity is sometimes referred to as the performance measurement baseline.
- This figure is an essential element in earned value management for determining contractor performance (from a cost perspective).

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# Budget at Completion (BAC)

- BAC is the total projected budget of all the work performed during the entire project—total planned value (PV)
- The CAPM and PMP exams usually provide the BAC.

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# Earned Value (EV)

- Amount (value) of work actually performed during a Work Breakdown Structure component or schedule activity.
- EV is sometimes referred to as the budgeted cost of work performed (BCWP).

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# Actual Cost (AC)

- Cost of all the work performed during a Work Breakdown Structure component or schedule activity.
- AC is sometimes referred to as the actual cost of work performed (ACWP).

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# Schedule Variance (SV) (1)

- $SV = \text{Earned Schedule} - \text{Actual Time}$
- If the result is **positive**, the project is ahead of the (schedule) baseline. If the result is **negative**, the project is behind schedule according to the (schedule) baseline.

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# Schedule Variance (SV) (2)

- Assuming a project's product is completed in scope, SV will equal zero when the project is complete.
- SV is often used in conjunction with the critical path methodology and risk analysis to assess project performance with respect to scheduling.

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# Cost Variance (CV) (1)

- $CV = \text{Earned Value} - \text{Actual Cost}$
- If the result is **positive**, the project is under budget. If the result is **negative**, the project is over budget.
- End of project CV is equal to Actual Cost (entire project) minus Budget at Completion.

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# Cost Variance (CV) (2)

- CV is one of the most critical measurements of project performance since it reflects what is actually being achieved as the project is being executed relative to the amount of money being spent.
- Typically, any losses reflected by a negative CV cannot be recovered.

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# Schedule Performance Index (SPI) (1)

- SPI is a measure of schedule efficacy
- $SPI = \text{Earned Schedule} / \text{Actual Time}$

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# Schedule Performance Index (SPI) (2)

- If  $SPI > 1$ , the project is ahead of schedule (more value has been achieved than what was planned for at this particular point).
- If  $SPI < 1$ , the project is behind schedule (less value has been achieved than what was planned for at this particular point).

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# Cost Performance Index (CPI) (1)

- CPI is a measure of cost efficacy
- $CPI = \text{Earned Value} / \text{Actual Cost}$

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# Cost Performance Index (CPI) (2)

- A CPI greater than 1 indicates cost performance is better than anticipated.
- A CPI less than 1 means cost performance is worse than predicted.
- CPI is the most important earned value metric.

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# Variance at Completion (VAC)

- Measure of projected surplus or deficit at end of project
- $VAC = \text{Budget at Completion} - \text{Estimate at Completion}$

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# Variance Analysis Formulas Summary

- $SV = ES - AT$  (or  $EV - PV$ )
- $CV = EV - AC$
- $SPI = ES/AT$  (or  $EV/PV$ )
- $CPI = EV/AC$
- $VAC = BAC - EAC$

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# Forecasting

# Trend Analysis: Forecasting (Data Analysis)

- Uses what is known now to make estimates or predictions about a project's status in the future.
- If it becomes clear that Budget at Completion is no longer an accurate measure of the project's projected total budget, the project team should conduct an Estimate at Completion.

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# Estimate at Completion (EAC)

- Estimated total cost of the project, WBS component, or scheduled activity as outlined by the project's scope.
- Typical EAC calculations involve adding Actual Cost to some sort of estimate of the remaining work (Estimate to Complete).

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# Bottom-Up Estimate at Completion (EAC) Method

- **EAC = Actual Cost + bottom-up Estimate to Complete**
- It is the most commonly used estimate at completion method.
- Problematic method because detailed Estimate to Complete formulations are time consuming and calculated by people actually doing project work
- Time and effort required to perform these calculations are often not programmed into the cost to perform the project.

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# Estimate at Completion (EAC) Method at Budgeted Rate

- When you expect current inconsistencies or variances with past project estimates to be temporary, the EAC formula is as follows:
- **$EAC = Actual\ Cost + (Budget\ at\ Completion - Earned\ Value)$**
- If the Earned Value equals Actual Cost, the project cost is exactly as predicted (i.e., Budget at Completion or budgeted); that is, there is no variance (Cost Variance = 0).

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# Estimate at Completion (EAC) Method at Present Rate

- When you expect current inconsistencies or variances with past project estimates to continue in the future, the EAC formula is as follows:
- **$EAC = \text{Budget at Completion} / \text{Cost Performance Index}$**
- If Cost Performance Index (CPI)  $> 1$ , cost underrun
- If CPI  $< 1$ , cost overrun

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# Estimate at Completion (EAC) Method Using Factors

- Assumption is cost performance to date has been negative and schedule cannot be altered (i.e., firm delivery date)
- **EAC = Actual Cost + [(Budget at Completion – Earned Value) / (Cost Performance Index x Schedule Performance Index)]**
- This formula is often used when schedule influences the estimate to completion costs (i.e., budget at completion minus earned value).

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# Estimate at Completion (EAC) Method Using Factors (2)

- Current CPI and SPI ratios are expected to continue for the duration of the project.
- The Cost Performance Index and Schedule Performance Index can be weighted differently in some instances (e.g., 60/40).

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# To-Complete Performance Index (TCPI) (1)

- TCPI calculates Cost Performance Index for remainder of venture and is based on a forecast from project management team
- What project must achieve (in terms of efficiency) to attain Budget at Completion or Estimate at Completion.
- When TCPI is greater than the Cost Performance Index (CPI), the existing CPI must improve to meet these forecasted efficiencies.

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# To-Complete Performance Index (TCPI) (2)

- Put another way, TCPI is how well the project must budget costs in whatever time remains (e.g., target CPI).
- For example, if the project is over budget, the project must come in under budget in the remaining schedule.

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# To-Complete Performance Index (TCPI) Budget at Completion Using BAC

- If Budget at Completion is still valid, use TCPI using BAC formula
- $(\text{Budget at Completion} - \text{Earned Value}) / (\text{Budget at Completion} - \text{Actual Cost})$

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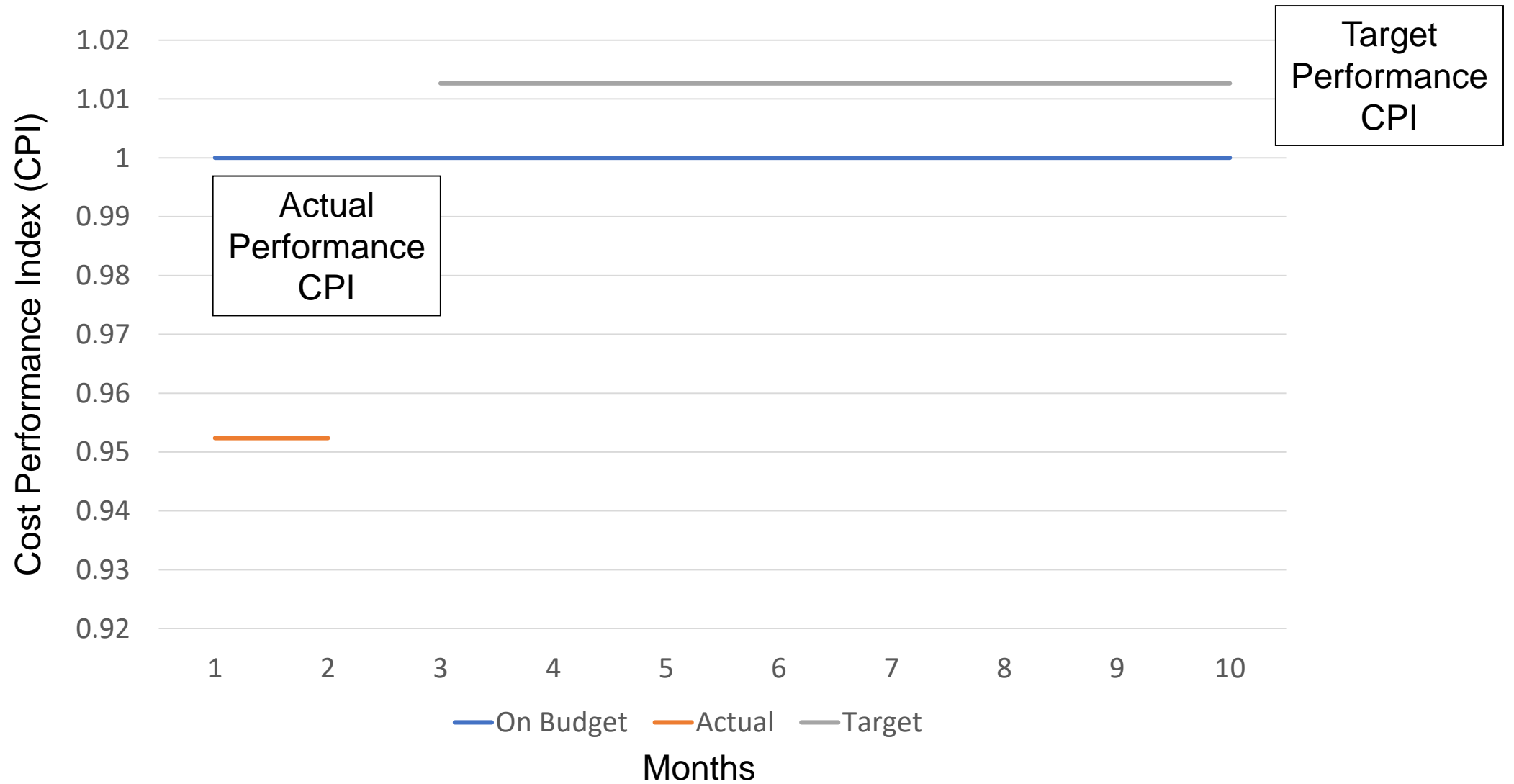
# To-Complete Performance Index (TCPI) BAC Example (1)

- A person receives an allowance of \$100 a month for 10 months.
- BAC = \$1,000



# To-Complete Performance Index (TCPI) BAC Example (2)

- After two months, the person has spent \$105 each month (i.e., \$10 over budget)
- $TCPI = (1,000 - 200) / (1,000 - 210)$
- $TCPI = 1.012$  (this is the target CPI)
- The person must “save” an average of \$1.25 each month over the next eight months

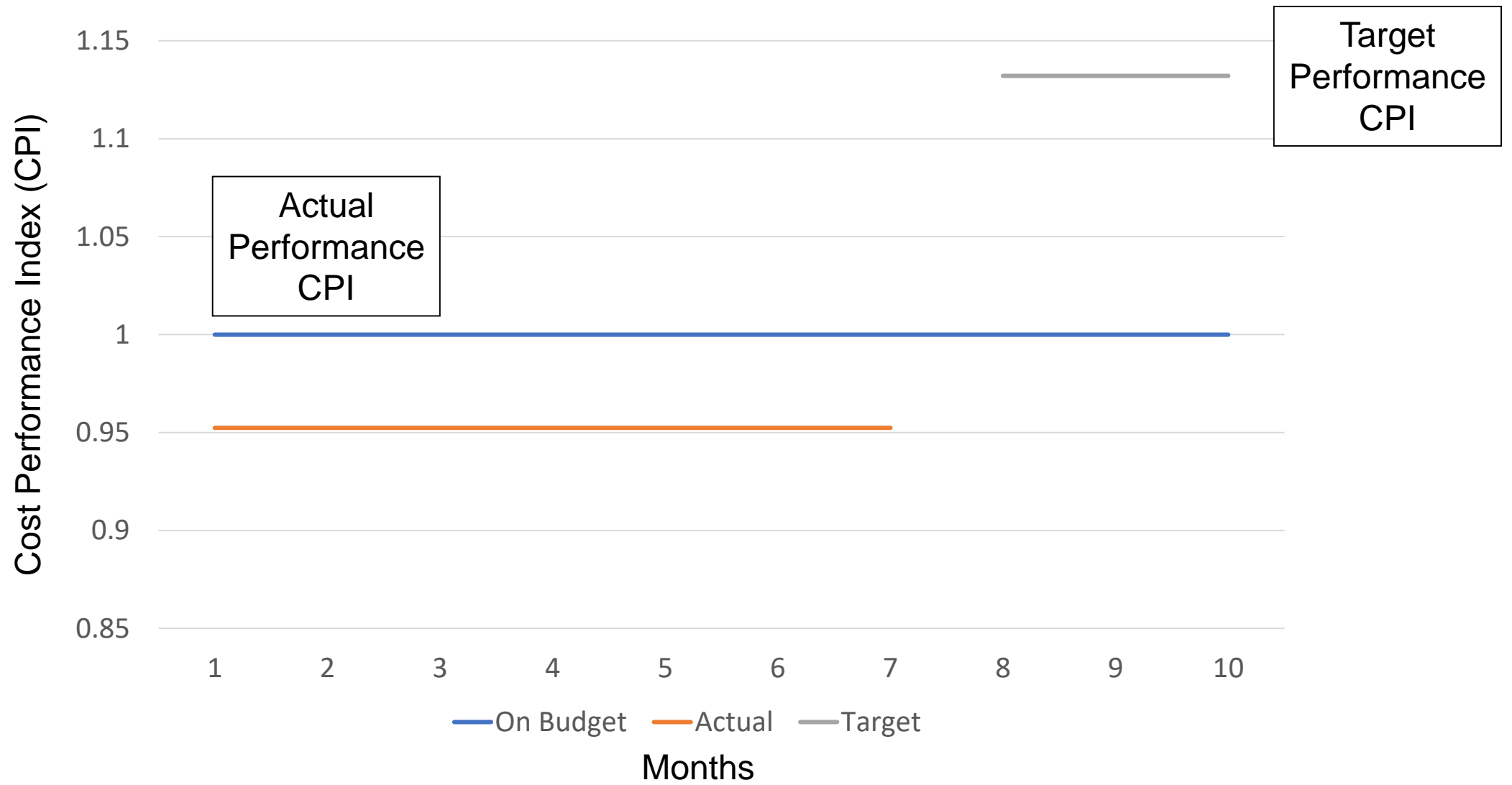


**Figure 7-5. To-Complete Performance Index (TCPI) Two Months Example**

# To-Complete Performance Index (TCPI)

## Another Example

- After seven months, the person has spent \$105 each month (i.e., \$35 over budget)
- $TCPI = (1,000 - 700) / (1,000 - 735)$
- $TCPI = 1.13$
- The person must “save” an average of  $\approx \$11.67$  each month over the next three months (versus \$1.25 each month in the last example)



**Figure 7-6. To-Complete Performance Index (TCPI) Eight Months Example**

# To-Complete Performance Index (TCPI) Estimate at Completion Using EAC

- If Budget at Completion is no longer valid, use TCPI using EAC formula
- $(\text{Budget at Completion} - \text{Earned Value}) / (\text{Estimate at Completion} - \text{Actual Cost})$

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# To-Complete Performance Index (TCPI) EAC Example (1)

- A person receives an allowance of \$100 a month for 10 months.
- BAC = \$1,000

# To-Complete Performance Index (TCPI) EAC Example (2)

- After two months, the person has spent \$105 each month (i.e., \$10 over budget)
- The sponsor (the person giving the allowance) decides the original budget was inadequate and decides to give the person receiving the allowance \$1,100 for the remaining work.
- Importantly, the value of the remaining work is still \$800 (even though the person will receive \$1,100).
- The new budget (estimate at completion) is  $\$210 + \$1,100$ , which is equal to \$1,310.

# To-Complete Performance Index (TCPI) EAC Example (3)

- TCPI using EAC =  $(BAC - EV) / (EAC - AC)$
- TCPI =  $(1,000 - 200) / (1310 - 210)$
- TCPI  $\approx .73$
- Why is TCPI below 1 in this example? \$800 worth of work remains, and the person performing the work has \$1,100 to complete the work. In one sense, the person can be less efficient in completing the remaining work. This accounts for the .73 target CPI.



# Forecasting Formulas Summary

- $EAC = AC + \text{bottom-up ETC}$
- $EAC = AC + (BAC - EV)$  (changes are temporary)
- $EAC = BAC/CPI$  (changes are permanent)
- $EAC = AC + [(BAC - EV)/(CPI \times SPI)]$
- $TCPI \text{ using BAC} = (BAC - EV) / (BAC - AC)$
- $TCPI \text{ using EAC} = (BAC - EV) / (EAC - AC)$

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Questions?